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P U B L I C A T I O N S
O F T H E
Astronomical Society of the Pacific.

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THE WORK OF AN ASTRONOMICAL SOCIETY.

*Address delivered before the Astronomical Society of the Pacific, March 30, 1889,
by EDWARD S. HOLDEN, LL. D., Director of the Lick Observatory.*

In the year 1820 the state of Astronomy in England was somewhat as follows: The Royal Observatory at Greenwich was pursuing its regular routine observations of the positions of the sun, moon and stars under the direction of the Astronomer Royal, POND, whose chief service to Astronomy consisted in the minute accuracy of his observations and in the faithfulness with which they were amassed and discussed. His controversy with BRINKLEY (Astronomer of the Dublin Observatory) on the latter's determination of stellar parallaxes, cleared the way for the great researches of BESSEL and STRUVE on the same subject, which followed a dozen years later. The Radcliffe Observatory at Oxford was in operation, but no observations were published. The Cambridge Observatory was just founded. The Observatory at Edinburgh was barely built, and was not yet a public institution. The Armagh Observatory had no instruments of importance and was doing no work. GROOMBRIDGE's private observatory at Blackheath was busy with his catalogue of 4243 circumpolar stars. Sir WILLIAM HERSCHEL, the greatest of practical astronomers and the glory of England (then 82 years old), was resting from his labors. His son, Sir JOHN HERSCHEL, had not yet begun that long series of observations which has made his name illustrious.

On the Continent, the magnificent labors of BESSEL, GAUSS, OLBERS and STRUVE were laying the foundations of the science of to-day. The spirit of their methods made itself known in England and deeply affected some of the younger men at the universities—notably BABBAGE, DEAN PEACOCK, and Sir JOHN HERSCHEL. These three entered into a compact, which was most fruitfully carried out, "to leave the world wiser than they found it." One of the most important results of this resolution was the founding of the Royal Astronomical Society of London—an institution which has done incalculable

lable good in fostering the science of Astronomy, not only in England, but throughout the whole civilized world. It is not part of my purpose to trace the influence of this society, nor to show in detail what its work has been. I rather wish to quote here a few paragraphs from the "Address of the Society, Explanatory of their Views and Objects," which was circulated in the year 1820, at the time of its foundation. And I wish to do this for two reasons; because, first, the need of such an association in our own midst is much the same as that felt by HERSCHEL and BABBAGE in England sixty years ago; and, secondly, because the programme of this society may point out to us along what lines we should proceed to make our own newly formed Astronomical Society equally useful in its own sphere.

The times have changed since then, no doubt. The immediate problems of Astronomy are different; but the spirit of the methods by which they are to be attacked and solved is eternally the same; and the need for co-operation and concentration of forces is more and more pressing as the complexity of processes becomes greater and greater.

I ask you, then, to listen to a few brief extracts from the first printed paper of the Royal Astronomical Society, and to imagine to yourselves the state of English Astronomy of that day, when the elder HERSCHEL had finished his work, and when the host of English amateurs of to-day was represented by GROOMBRIDGE, toiling at the observations and the reductions of his polar catalogue:

"In a country like Great Britain, in which the sciences in general are diligently cultivated, and *Astronomy* in particular has made extensive progress and attracted a large share of attention, it must seem strange that no society should exist peculiarly devoted to the cultivation of this science; and that Astronomy, the sublimest branch of human knowledge, has remained up to the present time unassisted by that most powerful aid; and has relied for its advancement on the labors of insulated and independent individuals.

"It may be conceived by some that Astronomy stands less in need of assistance of this kind than any other of the sciences; and that, in the state of perfection which its physical theory has already reached, its ulterior progress may safely be intrusted to individual zeal and to the great national establishment exclusively appropriated to celestial observations; or, at all events, to those public institutions and academies in all civilized nations whose object is the general cultivation of the mathematical and physical sciences. It may therefore be necessary to state the useful objects which may be accomplished, and the impediments which may be removed, by the formation of a society devoted solely to the encouragement and promotion of Astronomy.

"Owing to the great perfection which the construction of optical instruments has attained in England, and the taste for scientific research universally prevalent, there have arisen in various parts of the kingdom a number of private and

public observatories, in which the celestial phenomena are watched, and registered with assiduity and accuracy, by men whose leisure and talents peculiarly adapt them for such pursuits; while others, with a less splendid establishment, but by the sacrifice of more valuable time, pursue the same end with equal zeal and perseverance. Considerable collections of valuable observations have thus originated; by far the greater part of which, however, owing to the expense and difficulty of publication and various other causes, must inevitably perish, or at least remain buried in obscurity, and be lost to all useful purposes, unless collected and brought together by the establishment of a common center of communication and classification, to which they may respectively be imparted.

"This great desideratum, it is presumed, will be attained by a society founded on the model of other scientific institutions, having for one of its objects the formation of a collection or deposit of manuscript observations, etc., open at all times for inspection, to which the industrious observer may consign the results of his labors, with the certainty of their finding a place, among the material of knowledge so amassed, exactly proportioned to their intrinsic value. At the same time it will thus be rendered practicable to form a connected series from a mass of detached and incomplete fragments; and the society will render a valuable service to science, by publishing, from time to time, from this collection, such communications or digests as seem calculated, by their nature and accuracy, either to supply deficiencies or to afford useful materials to the theoretical astronomer.

* * * * *

"It is almost unnecessary to enumerate the advantages likely to accrue from the encouragement which an Astronomical Society may hold out; but among others may be mentioned the perfecting of our knowledge of the latitudes and longitudes of places in every region of the globe; the improvement of the lunar theory, and that of the figure of the earth, by occultations, appulses, and eclipses simultaneously observed in different situations; the advancement of our knowledge of the laws of atmospherical refraction in different climates, by corresponding observations of the fixed stars; the means of determining more correctly the orbits of comets, by observations made in the most distant parts of the world; and, in general, the frequent opportunities, afforded to a society holding extensive correspondence, of amassing materials which (though separately of small importance) may by their union become not only interesting at the present time, but also valuable as subjects of reference in future.

"By means of corresponding members, or associates, in distant countries, the society may hope to unite the labors of foreign observers with their own; and by thus establishing communication with eminent astronomers and institutions in all parts of the world, to obtain the earliest intelligence of new discoveries and improvements, which it may, perhaps, be desirable to circulate among such of its members as may profess themselves anxious to receive it, without loss of time.

"The circulation also of notices of remarkable celestial phenomena about to happen (with a view to drawing the attention of observers to points which may serve important purposes in the determination of elements or coefficients) may form another, and perhaps not the least interesting object of the society. To have the same phenomena watched for by many observers is the only sure way of having them observed by some; and moreover, the attention of an astronomer may frequently be aroused by a formal notice, especially when accompanied with directions for observing the phenomenon in the most effective way, when prob-

ably the mere ordinary mention of it in an ephemeris might fail to attract his observation.

"One of the collateral advantages of a society including many practical astronomers among its members (but which will appear of no small importance to those who possess good instruments) will be the mutual understandings which will be propagated among amateur astronomers, by frequent meetings and discussion, as to the relative merits of their instruments; and as to the talents and ingenuity of the various artists, both of our own and of foreign nations; not to mention the emulation which this must naturally excite to possess the best instruments; and the consequent tendency of such discussion towards a further improvement in their construction, or to the discovery of new ones.

"As the extent of the funds of the society must depend on the number of its members, it is impossible to conjecture at present how far its views respecting their application may extend. Besides the ordinary expenses attending an institution of this nature, the annual or occasional publication of communicated observations; the payment of computers employed in the reduction and arrangement of observations, or in computing the orbits of new planets, comets or other interesting bodies; the formation of an extensive astronomical library, not only of manuscripts, but also of printed books; and perhaps, at some future period, the proposals of prizes for the encouragement of particular departments of the science, either theoretical or practical, or for the improvement of astronomical instruments or tables, may be mentioned as worthy objects on which they may be bestowed.

"Such are the principal considerations which have actuated a number of individuals to form themselves into a society, under the name of the *Astronomical Society of London*, and to give this publicity to their determination, with a view of inviting others to unite in the prosecution of their plans. They have at the very commencement met with the most flattering success, which induces them to hope that, in a short time, every assiduous cultivator of the science will be found to have added his name to the list of members.

"The objects of the original members may be sufficiently gathered from what has been already said, and may be thus summed up in a few words, viz: to encourage and promote their peculiar science by every means in their power, but especially, by collecting, reducing and publishing useful observations and tables, by setting on foot a minute and systematic observation of the heavens, by encouraging a general spirit of inquiry in practical Astronomy, by establishing communications with foreign observers, by circulating notices of all remarkable phenomena about to happen and of discoveries as they arise, by comparing the merits of different artists eminent in the construction of astronomical instruments, by proposing prizes for the improvement of particular departments, and bestowing medals or rewards on successful research in all; and, finally, by acting as far as possible in concert with every institution, both in England and abroad, whose objects have anything in common with their own; but avoiding all interference with the objects and interests of established scientific bodies."

In our own case, we must remember how various are the opportunities and attainments of our different members, and try to lay the foundations of our efforts so broadly that every class will find a sphere of action in our programme, a stimulus in our proceedings, and a

support in our friendly association. The few professional astronomers in our midst will here lose that sense of intellectual and professional isolation which is a drawback and a danger. Nothing that is clearly conceived is too technical to be placed before an assemblage of intelligent men, and the very effort to explain gives a lucidity to the original conception which it might otherwise lack. There is a moral force, too, in knowing that one does not need to wait for sympathetic appreciation, but that it is to be found every day and all around one. The opportunity to communicate the results of one's work readily and quickly is of the highest value; and "the end of all observation is communication."

By far the greater number of our members will be amateurs, and here again we must recognize the fact that there are many classes with many differing opportunities and means for work and study. Some among us already possess telescopes of no inconsiderable power. In 1820, there was no refractor in Europe more powerful than the 5-inch telescope with which HERSCHEL and SOUTH observed their double stars. It should be the aim of the society to point out the directions in which such instruments can be used, so that either some useful result will be attained for the science, or so that, at least, the maximum amount of pleasure and personal profit can be had by the owners. I presume there are few amateurs who have not experienced a sense of disappointment in the use of their telescopes. It is not that the heavens are less glorious, nor that the observer is less devoted and enthusiastic, but it is because he often comes to feel that there is an aimlessness in his work which he finds to be disheartening. If at this moment some word or hint can be given to him which will show him how to employ his time and energies to some real advantage, either to science or to himself, the old enthusiasm will return and the labor will again become delightful. It is precisely such words and such hints that he may expect to find here among his colleagues.

There is an important class of our amateur members whose photographic experience and skill can bear the most useful fruits if they are directed toward certain astronomical ends. We also have professional astronomers among us, whose photographic knowledge is second to none. The association which this society makes easy and puts into an organized form, has already led to important results in the observations of the Solar Eclipse of last January by photographic means, and will, no doubt, continue to be fruitful. There are many other fields of research open to this method of observation.

We have other members, also, who have no apparatus for observation, but who have the ability, the leisure and the desire to forward Astronomy by computing the observations of others. There is a boundless field for such amateurs, and I am not sure that their efforts, if rightly directed, might not be of more real importance than any others. The Lick Observatory alone could provide the observations to keep a score of computers busy, and this work could be so selected as to be of all grades of difficulty and to employ every variety of talent.

Finally, we have among us those who have joined as learners; who are here to listen, to observe, to read and to study. They, in turn, should find in our meetings what they seek for and require. Their reading and their study can be guided, and it is among them that we may look for our workers after the next few years. Every class of talent and opportunity ought to find its profit either in our meetings or in our publications.

One word with regard to the conduct of our meetings. My own experience in scientific societies has led me to think that their meetings should never consist of mere lectures, no matter how interesting. There should be discussion, questions, remarks, interchange of ideas, contact of active minds. Let each member feel that he has a part to bear, both in the actual meetings and outside of them, among his associates. In one word, let our society be a live one—active, intelligent, modest, competent. It has a doubled interest in its two-fold place of meeting. The astronomers of the Lick Observatory can promise that the meetings held at Mount Hamilton shall be interesting and fruitful. The meetings held in San Francisco will also be full of interest.

One of the chief uses of the society will be to make an astronomical library available to the amateur observer. We have already made a beginning in this direction. It is not necessary that our collection should be very extensive. A complete astronomical library would contain, perhaps, 20,000 volumes. But it is desirable that we should own a full set of the most important astronomical journals. The progress of the science can be traced in their pages from day to day, and their past volumes give its history.

I have thought it worth while to give in a list which follows the titles of the more important astronomical periodicals, and I have ventured to add the names of some twenty or thirty books which our members would do well to own personally. It is not necessary to buy all of them at once, but the possession of one will lead to the

desire for another, as the scope of observation or of reading is enlarged. The society library should begin by owning these volumes. It will grow subsequently as our wants develop, both by purchase and by exchange with other scientific institutions:

ASTRONOMICAL JOURNALS.

Astronomische Nachrichten (established 1821); 2 vols. a year. Kiel; price, \$8.00.

Astronomical Journal (established 1851). Cambridge, Mass.; \$5.00.

Bulletin Astronomique (established 1884). Paris; \$4.75.

L'Astronomie (established 1882). Paris; about \$3.75.

The Observatory (established 1877). London; \$3.50.

Ciel et Terre (established 1880). Brussels; \$2.60.

Himmel und Erde (established 1888). Berlin; \$5.00.

Sirius (established 1868). Leipzig; \$2.60.

Wochenschrift für Astronomie (established 1847). Halle; \$2.70.

The Sidereal Messenger (established 1882). Northfield, Minn.; \$2.00.

Nature. London; \$6.00.

La Nature. Paris; \$6.00.

The Companion to the Observatory. London; published annually; 1s. 6d. [This latter work will take the place to the amateur observer which the *Nautical Almanac* holds to the professional.]

PUBLICATIONS OF ASTRONOMICAL SOCIETIES.

Publicationen der Astronomischen Gesellschaft. Leipzig; 4to (at irregular intervals).

Vierteljahrsschrift der Ast. Gesell. Leipzig; quarterly.

Memoirs and Monthly Notices of the Royal Astronomical Society. London; yearly and monthly.

Journal of the Liverpool Astronomical Society. Liverpool; monthly.

Bulletin de la Société Astronomique de France. Paris; yearly (?).

Publications of the Astronomical Society of the Pacific. San Francisco.

LIST OF SOME BOOKS OF REFERENCE IN ASTRONOMY.

HOUZEAU: *Vade Mecum de l'Astronome*; 8vo.

WOLF: *Geschichte der Astronomie*; 8vo.

DELAUNAY: *Cours Élémentaire de l'Astronomie*; 12mo.

LOOMIS: *Treatise on Astronomy*; 8vo.

CHAUVENET: *Spherical and Practical Astronomy*; 8vo; 2 vols.

BALL: *Elements of Astronomy*; 12mo.

YOUNG: *General Astronomy*; 8vo.

HERSCHEL: Outlines of Astronomy; 8vo.
 ARAGO: Astronomie Populaire; 8vo; 4 vols.
 FLAMMARION: Astronomie Populaire; 8vo.
 NEWCOMB: Popular Astronomy; 8vo.
 WEBB: Celestial Objects for Common Telescopes; 12mo.
 OLIVER: Astronomy for Amateurs; 12mo.
 PROCTOR: The Sun; 8vo.
 PROCTOR: The Moon; 8vo.
 PROCTOR: Saturn and His System; 8vo.
 LEDGER: The Sun, Its Planets and Their Satellites; 8vo.
 WATSON: A Popular Treatise on Comets, etc.; 12mo.
 SMYTH: Celestial Cycle; 2d ed.; revised by Chambers; 8vo.
 KLEIN: Star-Atlas (translation by McClure.)
 GLEDHILL: Handbook of Double Stars; 8vo.
 CHAMBERS: Descriptive Astronomy; 8vo.
 GRANT: History of Physical Astronomy; 8vo.
 CLERKE: History of Astronomy in the XIX Century; 2d ed.; 8vo.
 DELAMBRE: Histoire de l'Astronomie; 4to; 6 vols.

If our own publications are valuable and worthy, they will bring to us through exchanges many works of permanent value. This brings me naturally to the question of what and how much we ought to publish. On this I shall give my own opinion freely, from my personal point of view. It may easily be that my ideas on this question, which are rather positive, require correction. If they do, the experience of the society will be sure to show it.

It seems to me, then, that we should be extremely careful to make our publications fully worthy of the society. Any observation faithfully made and properly recorded well deserves a permanent place. Our very constitution, as a society of amateurs, will usually prevent us from presenting these long series of observations which can be amassed by professional observers in fixed observatories. But we should be careful not to make our publications a vehicle for the expression of mere unsupported opinion. A theory should always be accompanied by its vouchers. I would give more for one careful measure of a double-star, for one faithful observation of a comet, than for pages of speculation regarding the origin of the solar system. Such speculations have their place in science, no doubt, but to be valuable they must follow after years of work. We should make our papers a record of actual work accomplished. There is room, too, for *résumés* of the work of other observers and for papers relating to

the best methods of making our own observations. Important papers in other periodicals may well be translated and printed here. The pages of our journal should be truly representative of the work and thought of the society in general. It would be easy for the Lick Observatory staff to contribute enough material to completely fill such a journal; but it appears to me that, in general, the work of our observatory should appear in abstract only, and that the observations and communications from the amateur members of the society should always constitute the greater part of the publication. At the same time the observatory can serve a very useful end by furnishing a series of abstracts of work done and in progress and by printing notes on work proposed, especially if it is such that our members can co-operate in it. It will be a source of pride to us, if after many years we can look back over what has been printed by the society, and see that every part of it is the record of useful work faithfully done, and possesses a permanent value.

It is for this reason that it seems to me we should not attempt to print at any regular intervals, as monthly or quarterly. Let us keep our papers until we have enough material to form a number of 8, 16, 24 pages, and then issue and distribute this to our members and to our correspondents.

It is tolerably certain that the time has not yet come for us to perform another function of an astronomical society. I refer to the foundation and to the bestowal of the medal of the society as a reward for astronomical work of the highest class. It is certain, however, that in the future, if such a medal were founded, and if it were bestowed only for work of the highest class, as I have said, and never, under any circumstances, to one of our own members, that the responsibility of the award would constitute an important stimulus to the society itself, which would have to judge of the merits of the various works proposed to be rewarded; and that such awards, if always bestowed with judgment and discretion, would soon make the voice of our society respected everywhere. In fact, there is probably no way in which the society could do more good, and in which it could be more quickly influential, than by the bestowal of its medal upon those astronomers whose works fully deserve it. And there is probably no way in which a mistake of judgment would so quickly discredit us, as in the bestowal of our highest award upon insufficient scientific grounds, or for personal reasons.

It is probably quite time that I should leave these general considerations and come to the more special questions of the work which

our members may reasonably expect to do. In any particular case this depends very largely upon the time available for such occupation, upon the instrumental equipment at hand, and upon the individual aptitude and ability. I have already said that for those of us who are willing to calculate the observations made by others, there is an endless variety of work to do, of all grades of importance and difficulty. For those who have only the leisure to interest and divert themselves with observing, there is a rational and useful method to follow, instead of a random one, which will inevitably lead to disappointment. For those who are willing to spend a very little time and money, there are many fields, both old and new, needing cultivation. Let me mention a few of these fields—speaking very briefly of each one:

A very cheap telescope will serve to photograph the sun, provided it be of tolerably long focus. It is highly desirable to obtain enlarged pictures of the solar spots, and to repeat in this country the solar photographs of JANSSEN, which are taken with extremely short exposures—say, from $\frac{1}{1000}$ to $\frac{1}{2000}$ of a second of time. A series of careful counts of the number of new groups and new spots can be made with a very small telescope, and will be very useful. If any one of the society will charge himself with the necessary measurements, we, at Mt. Hamilton, will undertake to furnish daily photographs of the sun on a scale of $4\frac{1}{2}$ inches to the solar diameter for the purpose.

I believe that much can be done by studying the moon's surface with comparatively small telescopes. In such studies I think it desirable to confine the attention to very limited areas, and to study and draw these over and over again, under every possible variety of illumination, until the telescope and the observer can do no more. In this way it may be that only small areas will be covered, but it is certain that our knowledge can be materially increased. The observation of the occultations of stars is most useful, provided the position of the observing station and the local time are accurately known. The Lick Observatory time-signals can be readily made available for this purpose. Probably little can be added to our knowledge of the surface features of the planets by observations with the smaller telescopes. It is, however, well worth the labor for several of our members to maintain a series of observations of the eclipses of the satellites of *Jupiter*. There is nowhere in America, I believe, such a series maintained. The results of this work will be directly comparable with the observations on which the present tables are founded, and constants of reduction can be determined by which these observations can be

employed in conjunction with long series already obtained elsewhere. In this case, as in so many others, our great distance in longitude from the centers of observation, will give to our work a peculiar value. We are eight hours west of Greenwich and three hours west of Washington, and there is no astronomical establishment between us and Japan, and no active observatory between California and Australia. There is a whole field of photometric work (both visual and photographic) which is open to amateurs, and which needs cultivation. I refer especially to the photometry of different portions of the sky under illumination by the sun or by the moon.

Photographs of the planets and neighboring stars of about the same brilliancy on the same plate may very likely be of use in comparing their relative brightness. Should a bright comet appear, no chance should be lost to photograph it, to study the changes in its head, and to map the position of its tail among the stars.

The observations of GOTTHARD, on nebulæ, by means of long-exposure photographs have proved that even comparatively small telescopes (provided with driving clocks), properly used, are capable of giving the most brilliant and important results. It is at least possible that the Zodiacal Light, the Milky Way, the Twilight Arch, the Aurora, can be photographed. I know of no direction where the skill of amateur photographers could be better spent than in experiments upon these subjects. The problem is of the same nature as the photography of the faint outlying streamers of the Solar Corona, in which our California amateurs have been so successful.

The field in which amateurs can render the greatest service, however, is in the observation of the variable stars. If these are to be observed by the eye, the use of a mere opera-glass or of a very small telescope is usually sufficient to fix the time of maximum or minimum light with accuracy, by comparisons with neighboring stars which do not vary. Professor PICKERING has already presented to the Society a set of printed instructions for making such observations. If the observer has a photographic telescope or camera, the most elegant and accurate method might be to allow the star's image to *trail* over the plate. When the trail is weakest the star has reached its minimum. A scale of time can be put upon the plate by capping or uncapping the lens at known instants. If the star is too faint to trail on the plate while the latter remains at rest, a very simple clock-work motion can be devised which will cause the telescope to follow the star towards the west at a slow rate. This rate can be so chosen by experiment as to make the *trail* of suitable brightness for measurement.

There are scores of other researches of interest and importance which I have not time to mention and which are well within the reach of amateurs. One competent sextant observer, acting in concert with the Lick Observatory, could render a real service to the geography of the State, with very little expenditure of time and money, by determining the latitudes and longitudes of important points. If such an observer were to fix the positions of the eclipse stations occupied by the various parties on the 1st of last January, he could thus make a positive contribution to science. Mr. KEELER, of the Lick Observatory, has just completed a determination of the position of Norman, for this purpose, as a beginning.

I believe the radiant points of the brighter and more slowly-moving meteors can be accurately fixed by photography, and at any rate the experiment is worth a trial. Statistics of the number of telescopic meteors in different parts of the sky and at different hours are very much needed and are extremely easy to obtain.

I have thus hastily gone over the principal lines along which we, as a society, may hope to work with success. If we undertake all or any of the work thus indicated, and if we carry it on with faithfulness and industry, we may be sure that our efforts will be a veritable aid to science. Whatever we do, let us do thoroughly. Whatever we say, let it be well considered. Let us clearly understand the objects for which we are organized, and let us pursue these with entire confidence. The scope and membership of this society are such that it can have no antagonisms and rivalries with any other. But we may look forward to a career of real usefulness, not only to our members, but to the science of Astronomy. In our own time and way we may hope to make advances in this path, and we may be sure that we can diffuse information in its regard, and help to increase the intelligence, the activity and the pleasure of all our members.

EDWARD S. HOLDEN.

LICK OBSERVATORY, February 15, 1889.